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AUTHOR Salley, Charles D.
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ABSTRACT

Accurate enrollment forecasts are a prerequisite for reliable budget projections. This is because tuition payments make up a significant portion of a university's revenue, and anticipated revenue is the immediate constraint on current operating expenditures. Accurate forecasts are even more critical to revenue projections when a university's revenue allocations are tied by a state funding formula to credit-hour enrollment. Unfortunately, budget forecasters often extrapolate the latest enrollment change indefinitely into the future. Such judgment can mistake short-term seasonal and cyclical variations for a change in the long-term growth trend. The risk of such a mistake is especially high when the growth trend is moderate, as in the 1970's, because short-term variations are more visible than they are during periods of rapid growth, as in the 1960's. Under present conditions, if a temporary increase in enrollment one year is extrapolated as a trend change to the following year, underbudgeted years will alternate with overbudgeted years. This means year-end travel and procurement curtailments. The study suggests that this type of error can be avoided by using traditional techniques of time series analysis to identify fairly stable short-term enrollment patterns. Forecasters can then view enrollment fluctuations as a composite of short-term variations and the long-term trend variation. The techniques are demonstrated as applied at a large urban public university. (Author)

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PREDICTING NEXT YEAR'S RESOURCES--
SHORT-TERM ENROLLMENT FORECASTING FOR
ACCURATE BUDGET PLANNING

Charles D. Salley, Research Associate
Office of Institutional Planning
Georgia State University
University Plaza
Atlanta, Georgia 30303
404-658-2570

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Abstract

Accurate enrollment forecasts are a prerequisite for reliable budget projections. This is because tuition payments make up a significant portion of a university's revenue, and anticipated revenue is the immediate constraint on current operating expenditures. Accurate forecasts are even more critical to revenue projections when a university's revenue allocations are tied by a state funding formula to credit-hour enrollment.

Unfortunately, budget forecasters often extrapolate the latest enrollment change indefinitely into the future. Such judgment can mistake short-term seasonal and cyclical variation for a change in the long-term growth trend.

The risk of such a mistake is especially high when the growth trend is moderate, as in the 1970's, because short-term variations are more visible than they are during periods of rapid growth, as in the 1960's. Under present conditions, if a temporary increase in enrollment one year is extrapolated as a trend change to the following year, underbudgeted years will alternate with overbudgeted years. This means year end travel and procurement curtailments.

The study suggests that this type of error can be avoided by using traditional techniques of time series analysis to identify fairly stable short-term enrollment patterns. Forecasters can then view enrollment fluctuations as a composite of short-term variations and the long-term trend variation. The techniques are demonstrated as applied at a large urban public university.

Predicting Next Year's Resources--
Short-Term Enrollment Forecasting for
Accurate Budget Planning

Accurate enrollment forecasts are a prerequisite for reliable budget projections. This is because tuition payments make up a significant portion of a university's revenue, and anticipated revenue is the immediate constraint on current operating expenditures. Accurate forecasts are even more critical to budget projections when a university's revenue allocations are tied by a state funding formula to credit-hour enrollment (Moss & Gaither, 1976).

In recent years, the budget forecasting task at many universities has become more difficult than it was during the rapid growth years of the 1960's. The common explanation is that enrollment variations since the early 1970's have been erratic. Actually, the variations only appear erratic when forecasters interpret the latest enrollment change as a lasting trend change.

Unfortunately, this focus on trend change has been fostered by researchers who, in developing trend projection models for higher education enrollments, have tended to overlook techniques useful in projecting short-term seasonal and cyclical enrollment variations.¹ While trend projection techniques can indicate the general level of future expenditures, both curve fitting and causal models, as currently used, have only limited application to projections which deal with one fiscal year at a time.

In contrast, traditional time series analysis appears to be very useful for specific year-to-year revenue projections for budget purposes. This textbook statistical approach counters the human tendency to extrapolate the latest enrollment change indefinitely into the future. In cases where a short-term seasonal or cyclical variation is mistaken for a change in the long-term growth trend, extrapolation seriously compounds the error.

The risk of mistaking a seasonal or cyclical variation for a trend

change is minimal during a rapid growth period when the trend increase swamps the short-term variation. Consequently, simple extrapolation worked well in the rapid growth environment of the 1960's.

However, with the moderated growth trend of the 1970's, the situation is reversed. Short-term variation can now dominate the smaller trend increases and become highly visible. Under these conditions, if a temporary increase in enrollment one year is extrapolated as a trend change to the following year, underbudgeted years will alternate with overbudgeted years. This means year end travel and procurement curtailments.

The present study suggests that this type of error can be avoided by using traditional techniques of time series analysis to identify fairly stable short-term enrollment patterns. Forecasters can present quarterly enrollment fluctuations as a composite of short-term variations and the long-term trend variation. Hopefully, administrators would then no longer view the latest enrollment change as a trend change.

Plan of the Study

The study first reviews the seemingly erratic changes in total credit hour enrollment witnessed at a large urban public university since 1972 and the correspondingly poor performance of extrapolated budget forecasts made during this period. The study then presents the time series analysis of the university's enrollment variation from fiscal 1968 to 1977. The analysis identifies the unanticipated enrollment behavior during the 1970's as short-term variations from a growth trend that has, in fact, remained stable. This sort of information can improve forecast accuracy whether incorporated in subjective enrollment projections or in quantitative projection models. A simple linear model that incorporates short-term variations is demonstrated.

The Divergence of Budgeted and Actual Credit Hours
1972-1977

The rapid growth trend that credit hour enrollment established at the subject university during the 1960's was not sustained in the opening years of the 1970's. This moderation of the enrollment growth trend reflected the national pattern as the college-aged population "surge" peaked out.

Inexplicably, strong growth reemerged in fiscal 1975 and 1976. Then, in 1977, enrollment reversed into an actual decline. These events made the task of forecasting credit hour growth for budget purposes more difficult than it had been during the steady growth years of the 1960's.

Insert Figure 1 About Here

As seen in Figure 1, budgeted credit hours (broken lines) were substantially over the actual credit hour figures (solid lines) for two years in the early seventies. Then, in fiscal 1976, the budget forecast was under the actual figure by a large difference. This was typical of projections throughout higher education for that year. The following year, the forecast was again over the actual figure, resulting in a situation where overbudgeted years tended to alternate with underbudgeted years. Forecasting errors have been as high as 20,000 credit hours per quarter during the period of seemingly unpredictable enrollment behavior.

Time Series Analysis of Enrollment Patterns

Traditional time series analysis can produce an orderly interpretation of these events. First, the analysis identifies the seasonal variation in the quarter credit hour data series using a moving average technique (Mills, 1955). Figure 2, taken from a recent study of the university's enrollment patterns (Salley, 1977), shows a regular annual variation in credit hours from quarter

to quarter over a ten-year period. The chart also shows the credit hour data adjusted for this seasonal variation by dividing each quarter's enrollment figure by the respective seasonal index.²

Insert Figure 2 About Here

The seasonally adjusted credit hour figures are then measured for trend variation using a least-squares curve fitting technique. Figure 3 shows the growth trend fitted to the seasonally adjusted data series.³

Insert Figure 3 About Here

A change in the growth trend is evident. A period of very rapid expansion drew to a close in fiscal 1971. There has followed a period evidencing a relatively lower growth rate.

In the next step of the analysis, the isolated trend variation is subtracted from the deseasonalized data series, leaving residual values, which in this case, are cyclical.⁴ The cyclical pattern of the residual values is visually more apparent if the trend lines are drawn horizontally to emphasize the cyclical divergence of the seasonally adjusted credit hour figures from the fitted growth trend.

Insert Figure 4 About Here

To see if these quarters of enrollment expansion and contraction around the growth trend relate to periods of economic expansion and contraction, the residual values are compared with the National Bureau of Economic Research's (NBER) index of coincidental indicators. This is an index of economic data series whose turns in the past have coincided roughly with those of successive business cycles.

Insert Figure 5 About Here

The chart suggests that the university's enrollment variation does parallel economic activity. However, the correlation is inverse, that is, an increase in enrollment appears to accompany a decrease in economic activity. Thus, the unexpected 1975 upsurge in enrollment appears to have been a temporary consequence of falling employment rather than a dramatic, long-term change in the growth trend.

This cyclical relationship can be measured more precisely. Simple regressions give an exact correlation coefficient between the credit hour residuals and various measures of local and national economic activity. Table 1 shows typical results of these regressions.

Insert Table 1 About Here

The cyclical variation in the university's credit hour enrollment correlates highly (though inversely) with the cyclical variation in the local area employment. The relationship holds for both the FY 1968-71 rapid growth period and for the FY 1972-77 moderate growth period. During the more recent period, the highest correlation coefficient for enrollment variation and local employment variation is attained during the same quarter. In other words, a decrease in local employment during a particular quarter coincided with a like increase in the university's enrollment during the same quarter.

Other measures of variation in economic activity also correlate highly with the cyclical variation in enrollment. A close parallel is the .733 coefficient for the NBER index of leading indicators. In this case, however, the highest coefficient is attained by lagging the index values three quarters. This means that a decrease in the economic index value during a particular

quarter coincided with an increase in enrollment three quarters later. This lead-lag relationship has strong potential for short-term forecasting purposes.

Use of Seasonal and Cyclical Factors
in an Explanatory Equation

The time series analysis identified the seasonal, trend, and cyclical components of the quarterly variation in credit hours. To test how well these three isolated factors account for or "explain" quarterly enrollment variation, they can be used as components of a standard linear regression equation which is fitted to the actual data. The equation takes the general form:

$$a + B_1(X_1) + B_2(X_2) + B_3(X_3) + e = Y, \quad (1)$$

where Y is total credit hours described as a function of $B_1(X_1)$ a trend factor, $B_2(X_2)$ a seasonal factor, $B_3(X_3)$ a cyclical factor, and e, an error term (program changes and all other factors). A "good" explanatory equation is one where calculated B coefficients, together with the known X values, account for a much larger percent of the variation in the Y values than does the error term (Beals, 1972).

In this urban university's equation, the X_3 cyclical variable is the NBER index of leading indicators lagged three quarters, which the analysis found has a high correlation with the university's cyclical enrollment pattern. There are actually three seasonal B_2 coefficients and X_2 variables. These are categorical variables. If B_2 represents the winter quarter, X_2 takes the value of 1 when the Y credit hour value is for the winter quarter, and 0 for other quarters. The value 1 brings the appropriate seasonal factor into the calculation for that quarter. All X_2 values are 0 for the fall quarter Y values. The trend variable X_1 is simply the numerical series 1, 2, 3, . . . 24 for the quarters from FY 1972 to 1977.

The regression equation solved for the B coefficient values is

$$229569 + 1219 (\text{quarter 1-24}) + \begin{array}{l} - 49827 (\text{Summer}) \\ 0 (\text{Fall}) \\ - 1250 (\text{Winter}) \\ - 7564 (\text{Spring}) \end{array} - 538 (\text{NBER Index}) = \begin{array}{l} \text{Total} \\ \text{Quarter (2)} \\ \text{Credit} \\ \text{Hours} \end{array}$$

The R^2 value is .970. This means that the equation in this form explains 97 percent of the variation during the 1972-77 period. Also, the Durbin-Watson statistic is 2.11, which indicates there is no serial correlation.

Using the Equation for Short-Term Projections

The ability of the regression equation developed in the previous section to project future variation depends largely upon the forecaster's ability to project the underlying (independent) X variables. The seasonal X's are known since the school calendar remains basically the same each year. Also, the NBER leading index is known three quarters before its anticipated effect on enrollment. The trend value, however, is not known for future periods. While the trend path may be intuitively estimated from population trends and other exogenous factors, this estimate becomes a basic assumption for any projections made by such an equation.

For short periods of three or four quarters it seems reasonable to make the simplest assumption--that the present trend will continue. Given the trend assumption and current NBER values, the equation should do a fair job of projecting enrollment variation several quarters in advance.

As an example, appropriate seasonal and NBER values for each quarter in FY 1978 are substituted in equation (2) to obtain the corresponding projections.

a	Projection Equation			FY 1978 Total Credit Hours			
	Trend $B_1(X_1)$	Seasonal $B_2(X_2)$	Cyclical $B_3(X_3)$	Projected	(Actual)		
	229569 + 1219(25)	- 49827(1)	- 538(127.1) =	141837	(124705)	Summer	(3)
	229569 + 1219(26)		- 538(128.1) =	192345	(191152)	Fall	(4)
	229569 + 1219(27)	- 1250(1)	- 538(130.7) =	190915	(189056)	Winter	(5)
	229569 + 1219(28)	- 7564(1)	- 538(132.3) =	184960	(184122)	Spring	(6)

The projections assume present patterns will continue. An incorrect projection indicates that this assumption bears reexamination. For instance, the large summer quarter error reflects a major program change. Finally, separate equations should be estimated for junior, senior, and graduate divisions if the state budget formula specifies different workload factors for each level of instruction.

Summary

Enrollment forecasting is an integral part of the budget process, especially where the allocation of state funds to a university is tied by a formula to credit hour enrollment. Because of seemingly erratic variations in enrollment during the 1970's, the budget forecasting task at many universities has become more difficult in recent years than it was during the rapid growth years of the 1960's.

The problem is largely a common tendency to interpret the most recent enrollment variation as a lasting trend change. Extrapolation of the latest variation can be especially misleading during the current period of moderate trend growth. This is because short-term variations from the trend are more visible now than they were during the recently ended period of rapid trend growth.

Traditional methods of time series analysis can help identify recurring seasonal and cyclical variations so that quarter-to-quarter changes can be anticipated and not mistaken for a change in the long-term trend.

Such an analysis at a large urban public university found that enrollment follows the seasonal pattern typical of most academic institutions. Credit hours are low each summer quarter, rise sharply to a peak in the fall quarter, and then decline moderately during winter and spring quarters. Looking at the long-term trend pattern, a period of very rapid expansion drew to a close in fiscal 1971. There has followed a period evidencing a relatively moderate growth rate.

The analysis also found that the university's enrollment has varied with the rises and declines of business activity. Total enrollment has tended to increase more rapidly as business activity has declined.

Moreover, during the recent period of moderate trend growth, the cyclical swings in enrollment have been larger than the trend variation. This means that short-run cyclical changes in enrollment have masked the long-run trend. Hence, the unanticipated 1975 upsurge in enrollment was a temporary consequence of falling employment rather than a dramatic upturn of the growth trend. Extrapolation of that temporary increase led to painful budget cuts when the budgeted enrollment did not materialize the following year.

Figure 6 shows the variation in actual credit hour enrollment at the subject university over the past seven years initially presented in Figure 1. As a result of the time series analysis, the perceived erratic pattern of trend changes every two or three years gives way to the perception of an orderly seasonal and cyclical pattern revolving along a steady, moderate growth path.

Insert Figure 6 About Here

It appears that the recognition of short-run variation adds significant dimensions to annual budget enrollment projections beyond trend extrapolation. For example, Figure 6 also shows the projection for the coming fiscal year.

The forecast follows the 1972-78 trend, but allows for an anticipated business cycle influence and for the normal seasonal variation.

Whether forecasters use formal models or intuitive judgment, this study suggests that quarter-to-quarter variations in enrollment should not be taken as conclusive evidence of growth trend changes. During the 1970's and 1980's such changes will likely reflect the more predictable cyclical and seasonal variations.

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Footnotes

¹A recent study conducted by the National Center for Higher Education Management Systems (Wing, 1974) extensively surveyed the enrollment forecasting literature and examined actual forecasting projects at various universities and state-level agencies. The statistical techniques employed in the twenty-three projects reviewed indicate that research efforts nationally have focused on long-term trend projections. One enrollment study has hypothesized that cyclical employment variation affects enrollment (Witowski, 1974). However, no statistical measures of the possible influence are discussed.

²Actual computations in tabular form appear in the cited article which is available from ERIC.

³Two fitted trend lines are used because they have a smaller residual error than does a single fitted line, whether linear, exponential, or logistic (Salley, 1977, p. 7). Also, fitting simple linear trends visually emphasizes the one-time trend change and seems to facilitate communication.

⁴This step is surprising to researchers who routinely examine such residuals to insure that error terms are random. In contrast, the time series analysis seeks to isolate and account for systematic variation from the fitted trend.

Table 1

TABLE OF CORRELATION COEFFICIENTS
(Values may range from .000, no correlation,
to 1.000, perfect correlation)

<u>Quarterly Economic Indicators</u>	<u>Credit Hour Variation from Trend</u>	
	<u>1968-71</u>	<u>1972-76</u>
Local Non-Agr. Employment (% Variation from Trend)		
leading 1 qtr.	-.571*	-.597
same qtr.	-.500	-.742*
lagged 1 qtr.	-.340	-.480
NBER Leading Index		
lagged 2 qtrs.	-.718	-.678
lagged 3 qtrs.	-.725*	-.733*
lagged 4 qtrs.	-.687	-.648
NBER Coincidental Index		
same qtr.	-.722	-.537
lagged 1 qtr.	-.754*	-.659*
lagged 2 qtrs.	-.707	-.632

*highest correlation

Figure Captions

- Figure 1. Budgeted and actual credit hour enrollment
- Figure 2. Quarter-to-quarter seasonal adjustment
- Figure 3. Change in growth trend
- Figure 4. Cyclical enrollment variation
- Figure 5. Correlation of enrollment cycle with business cycle
- Figure 6. Budgeted and actual credit hour enrollment











